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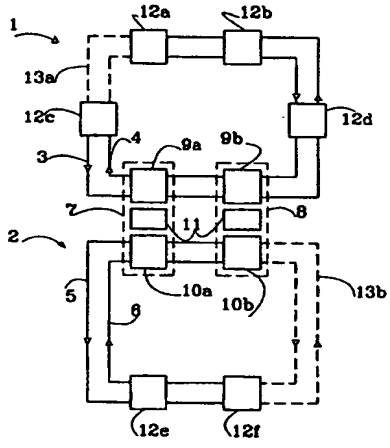
(54) Title: A METHOD AND A SYSTEM FOR INTERCONNECTING RING NETWORKS

(57) Abstract

The present invention relates to a system and a method for protecting an interconnection between two ring networks (1, 2). Each ring network (1, 2) comprises two communication paths (3, 4, 5, 6) and at least one node connected to both communication paths (3, 4, 5, 6). The two ring networks (1, 2) are interconnected via two gateways (7, 8). Each gateway (7, 8) is arranged to receive traffic from both communication paths (3, 4, 5, 6) on one ring network (1, 2) and to transmit said traffic to the other ring network (1, 2) on the communication path (3, 4, 5, 6) directed from the other gateway (7, 8). According to the invention the traffic is stopped in both directions in an inactive segment (13a, 13b) on each ring network, so that a node situated on a ring network (1, 2) receives traffic from only one of the two gateways (7, 8).



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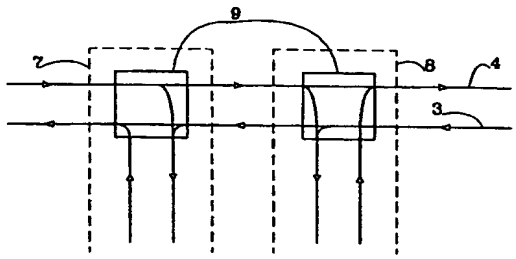

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A METHOD AND A SYSTEM FOR INTERCONNECTING RING NETWORKS

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method and a system for protecting an interconnection between ring networks.

DESCRIPTION OF RELATED ART

Wave Division Multiplexing (WDM) is a technology allowing the transmission of a number of optical signals through an optical fibre using different separated light wavelengths. In this way the information carrying capacity may be increased significantly. The capacity depends on the number of used wavelength channels and their bandwidth. The signal at each wavelength travels through the fibre irrespectively of the other signals, so that each signal represents a discrete channel with large bandwidth.

A ring communication network is made up of nodes, which are connected in tandem in a ring by a unidirectional communication path, such as an optical fibre. A node receives transmissions from an upstream node. The return traffic is transmitted downstream to the first node.

A drawback of such a network is that a break in the ring or a failure of a node would prevent any node upstream of the break/failure to communicate with any node downstream of the break. A usual solution to this problem is to in some way provide a second spare communication path parallel to the first, but in the opposite direction, see US 5,365,510, US 5,179,548 and EP 677,936. If communication fails somewhere on the first communication path, then the traffic is directed back on the second communication path and the wished node will thus be reached from the other side.

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Another solution is to send traffic on two communication paths in opposing directions, but with a segment of the ring inactivated for data traffic, see "Electronic letters", 5th December 1996, Vol.32, No 25, p 2338-2339, B.S. Johansson, C.R. Batchellor and L. Egnell: "Flexible bus: A self-restoring optical ADM ring architecture". In the case of a fault the segment is moved to the fault. It is however not described how to achieve this in practise.

If two ring networks shall communicate, there still exists a weak point, namely the node that interconnects the two ring networks. This problem is solved in an electrical version in US 5,218,604, in that two ring networks are interconnected via two parallel serving nodes. A ring network consists, in this case, of two parallel communication paths, of which one carries traffic in the clockwise direction and the other carries the same traffic in the counterclockwise direction.

In the first ring network traffic from both communication paths are received by both of the serving nodes via a so called "drop-and-continue" property. In each of the two serving nodes a selector selects from which communication path received signals will be retransmitted.

The two serving nodes then retransmit the received signals in a second ring network. Each serving node transmits away from the other serving node, with the result that the two communication paths in the second ring network carry the same traffic. The node to which the traffic is sent uses a selector to select from which communication path signals will be received.

SUMMARY OF THE INVENTION

A purpose with the present invention is to provide a protected interconnection between ring networks. A ring network will for short be called a "ring". The protection is done by using two parallel interconnecting nodes on a ring, which are coupled with two corresponding parallel interconnecting nodes on another ring and are called gateways. Signals entering a ring are routed across both gateways. A gateway may receive signals from both directions of the ring, but only transmits away from the neighbouring gateway.

So far the invention is similar to the invention in US 5,218,604. A problem with the invention in US 5,218,604 is that if an optical version is done, then expensive and not reliable optical selectors for each wavelength will have to be used. Another problem is that amplified spontaneous emission (ASE) is not stopped, which leads to saturation, higher noise level and oscillations.

The present invention solves the problem by using a different kind of nodes than the nodes in US 5,218,604 and in particularly by each ring comprising an inactive segment. The inactive segment ensures that nodes on the ring only receive signals from one of the gateways. In the event of a fault the inactive segment moves so it encompasses the fault. Hence, operation is ensured.

If the inactive segment lies between the gateways then one of the gateways features a detection mechanism that detects the situation. If the situation occurs, said gateway

suppresses transmission and just the other gateway transmits.

Other differences to US 5,218,604 is that they receive and retransmit all traffic in each node, which is not done in the present invention. Also, they have the same traffic in both rings and select from which ring to receive, but in the present invention it is possible to receive from both rings at the same time, since it is not the same traffic in both rings.

Advantages with the present invention are that a protected interconnection between ring networks are provided in a simple, autonomous and not expensive way.

In US 5,218604 there is also a problem of not being able to place nodes between the gateways. This is solved in an embodiment of the present invention by "dividing" the ring in an upper part and a lower part. The different parts of the ring use different wavelengths. The inactive segment is situated either in the upper or the lower part.

One of the gateways transmit always both in the upper and the lower part of the ring, using different wavelengths in the different parts, as mentioned. The other gateway transmit only in the part where the inactive segment is situated. The other gateway knows in which part of the ring to transmit and not due to the detection mechanism described above.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1a is a diagram of a network in accordance with the invention with an inactive segment in one position.

Figure 1b is a close view of two gateway nodes.

Figure 2 illustrates the same network as in figure 1a, but with the inactive segment in another position.

Figure 3a illustrates one embodiment of a node according to the invention.

Figure 3b is a principle diagram of the first node embodiment.

Figure 4a illustrates another embodiment of a node according to the invention.

Figure 4b is a principle diagram of the second node embodiment.

Figure 5 illustrates a first embodiment of the gateways corresponding to figure 3a.

Figure 6 illustrates a first embodiment of the gateways corresponding to figure 4a.

Figure 7 illustrates the same network as in figure 1a, but with the inactive segment in another position.

Figure 8 illustrates a second embodiment of the gateways corresponding to figure 3a.

Figure 9 illustrates a second embodiment of the gateways corresponding to figure 4a.

Figure 10a, 10b and 10c illustrates a network similar to the one in figure 1a, but with nodes between the gateways.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In figure 1a is shown, according to the invention, a first ring network 1 comprising two optical fibres 3 and 4 and a second ring network 2 comprising two optical fibres 5 and 6. A ring network will for short be called a "ring". In each ring 1, 2 the two fibres 3 and 4 or 5 and 6 work in opposite directions, which is indicated with arrows in the figure.

The two rings 1 and 2 are interconnected via a first gateway 7 to the left and a second gateway 8 to the right. Each gateway 7, 8 comprises a gateway node 9a, 9b, 10a, 10b on each ring 1, 2 and optionally some kind of crossconnect 11 between the two gateway nodes 9a, 9b, 10a, 10b. On the rings 1, 2 there may then be an arbitrary number of nodes 12a-f.

The rings 1, 2 each comprises an inactive segment 13, which is shown schematically as two dashed lines in the figures. In a normal mode the inactive segment may be situated anywhere on the ring 1, 2, but in the case of a fault the inactive segment 13 will move to the fault.

The inactive segment 13 on the ring 1 is situated between the nodes 12a and 12c, which thus become end nodes of a bus. The inactive segment 13 has arisen, because the two end nodes 12a and 12c both block reception from or transmission towards the place of the wished inactive segment. Examples regarding how to implement inactive segments will be given below.

Each gateway 7, 8 receives traffic from both directions, that is both fibres 4 and 5 or 6 and 7 in the ring 1 or 2.

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But, as a basic rule, the gateway 7, 8 only transmits away from its partner gateway 8, 7, which is shown in figure 1b. Hence, no nodes 12a-f should, in this first embodiment, lie on the direct path between the two gateways 7, 8.

The introduction of the inactive segment 13 ensures that each node 12a-f only receives traffic from one of the gateways 7, 8. The nodes 12c that are situated counterclockwise from the inactive segment 13 will receive traffic from the left gateway 7, whereas the nodes 12a, 12b, 12d that are situated clockwise from the inactive segment 13 will receive traffic from the right gateway 8.

As an example let us say that the node 12f below to the right in the lower ring 2 wants to transmit to the left upper node 12c in the upper ring 1. Transmission will in the lower ring 2 start in the node 12f and follow fibre 6 clockwise, since there is the inactive segment 13b in the counterclockwise direction.

The transmission will pass the node 12e and reach the left gateway 7, where it is splitted. One part of the transmission is received in the left gateway 7 for retransmission in the upper ring 1 and the other part continues to the right gateway 8, where it is also received for retransmission in the upper ring 1.

The left gateway 7 retransmits in the upper ring 1 away from the right gateway 8, that is following the fibre 4 clockwise. The transmission then passes the node 12c and then - there is a stop, because the inactive segment 13a is situated between the nodes 12a and 12c, which are thus acting as end nodes in the ring.

On the other hand the right gateway 8 retransmits in the upper ring 1 away from the left gateway 7, that is following the fibre 3 counterclockwise. The transmission then passes the nodes 12d and 12b and ends up in the wished node 12a.

If the inactive segment 13a had been situated between the nodes 12b and 12d instead, like in figure 2, it would instead have been the transmission from the left gateway 7 that had reached the wished node 12a - via the node 12c.

It is possible to obtain inactive segments in different ways. Two solutions will be presented.

In order to explain how an inactive segment is achieved the parts of a node that are relevant for the invention are shown in figure 3a.

The node is connected to the two fibres 3, 4. On each fibre 3, 4 the node comprises a first detector 21, a preamplifier 22, a second detector 23, a switch 24, a booster amplifier 25, a group of receivers 19 and a group of transmitters 20. Normally, there is one receiver/transmitter per channel, but, the groups of receivers 19 and transmitters 20 will for simplicity consequently be drawn as one block each. The amplifiers 22 and 25 are not necessary for the invention as such, but it is conceivable that they could work as switches and replace or complement the switch 24.

The first detector 21 detects loss of incoming power and the second detector 23 detects loss of incoming protection signals. The switch 24 is used to get an inactive segment. The transmitters 20 and the receivers 19 are used to add and drop channels to and from the ring.

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A central processor 26 controls everything and a protection signal transmitter 27 sends a protection signal PS on both the fibres 3, 4, that is in both directions, when the node acts as an end node.

In figure 3b is schematically shown a ring with four nodes 12a, 12b, 12c, 12d as in figure 3a. An inactive segment 13 lies between the end nodes 12a and 12b. The end nodes 12a and 12b both have their switch 24 towards the inactive segment 13 closed. That means that, as a main rule, no data traffic can be transmitted over the inactive segment 13.

However, both end nodes 12a, 12b transmit protection signals PSa and PSb, respectively, in both directions, that is also over the inactive segment 13. To facilitate the description we need to distinguish the protection signals going in different directions. For that reason the protection signals PSa and PSb transmitted counterclockwise are labelled PSa' and PSb'.

As may be seen in figure 3a the transmission of the protection signal PS occurs after the switch 24 and is thus not influenced of the state of the switch 24. This means that in a normal state each node 12a, 12b, 12c, 12d will receive four protection signals PSa, PSb, PSa' and PSb'.

A lot of conclusions may be drawn from the reception or non-reception of the protection signals PSa, PSb, PSa' and PSb'. Some examples will be given. Further examples are easily imagined. If the left end node 12a does not receive its own protection signal PSa', but receives the protection signals PSb, PSb' from the right end node 12b, then there is probably a fault on the fibre going over the inactive

segment 13 from the left end node 12a to the right end node 12b.

If the left end node 12a receives its own protection signal PSa' and the protection signal PSb' from the right end node 12b, but does not receive the protection signal PSb from the right end node 12b, then there is probably a fault on the fibre going over the inactive segment 13 from the right end node 12b to the left end node 12a.

If the left end node 12a does not receive its own protection signal PSa' and not receives the protection signal PSb' from the right end node 12b, but receives the protection signal PSb from the right end node 12b, then there is probably a fault on the fibre but not in the inactive segment 13. This is an indication on that the inactive segment 13 should be moved.

If the left end node 12a receives its own protection signal Psa', but not receives the protection signal PSb' from the right end node 12b, then there is probably a fault in the right end node 12b, but not in the inactive segment 13 and thus the inactive segment 13 should be moved.

If there is an indication that the inactive segment 13 should be moved and there is not a fault in the inactive segment, then the end nodes 12a, 12b will stop sending their protection signals PSa, PSa', PSb, PSb' and open their switches towards the inactive segment 13. Thus transmission is possible over the now former inactive segment 13.

Simultaneously, if the node 12c detects loss of incoming power by means of its first detector 21 on one side it is an indication of a fault on that side. Therefore the switch 24

on the fibre going towards that side closes and protection signals PSc starts to be transmitted in both directions. The corresponding will happen on the other side of the fault and thus a new inactive segment is created.

A fault occurring in a node instead of between two nodes may be taken care of in a corresponding way.

Now a second embodiment of obtaining inactive segments will be explained. In figure 4a are shown the parts of a node that are relevant for the invention. Much is the same as in the first embodiment and only the differences will be marked.

The node is connected to the two fibres 3, 4. On each fibre 3, 4 the node comprises the detector 21, the preamplifier 22, the booster amplifier 25, the receivers 19 and the transmitters 20.

The detector 21 detects loss of incoming power and the preamplifier 22 works as a switch. The central processor 26 controls everything and a supervision unit 28 sends an alarm signal SS on both fibres 3, 4 in a separate wavelength channel. The alarm signal SS is sent circling around the ring from node to node in both directions all the time. The alarm signal SS is a fault flag, which is set in the case of a fault. In that case there is also an indication in the wavelength channel on which section is inactive.

In a non faulty state the inactive segment is achieved by shut off preamplifiers blocking reception in the end nodes from the inactive segment. As an alternative it is conceivable to use the booster amplifiers to block transmission instead of using the preamplifiers to block

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reception. There are, however, advantages of blocking reception, because then signals are present at the input of the shut off preamplifier. This means that a fault occurring in the present inactive segment may be detected by loss of power. It also means that the signals may be used to adjust the future amplification of the preamplifier, so that when the preamplifier is turned on it will have the correct amplification at once.

Conventional switches may be used also in this embodiment. It is, however, more economic and more reliable to use the amplifiers as switches, since then fewer items are necessary.

If a node detects loss of incoming power, then both the preamplifier and the booster amplifier in the direction towards the fault will shut off like a switch. One reason for shutting off also the booster amplifiers is for ensuring a segment deactivation in the case of unidirectional faults. Another reason is for human eye safety reasons.

Thus, said node becomes an end node and a new inactive segment will be created much like the process in the first embodiment. However, in this case also the alarm signal SS will be set in the supervision channel.

The node on the other side of the fault will also try to set the same alarm signal SS, which gives a redundancy in case of node faults.

When the other nodes receive the set alarm signal SS they will know that a fault has occurred. The former end nodes, which had their preamplifiers shut off towards the inactive segment will now activate their preamplifiers. Thus, the

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inactive segment is moved, much in the same way as in the first embodiment.

The set alarm signal SS will also prevent the inactive segment to move a second time before the fault has been repaired, because moving is only allowed if the alarm signal SS is not set.

Of course, the supervision channel may also perform other types of signalling at the same time.

In figure 5 a pair of gateways nodes 9a, 9b are shown. They contain all the features of the nodes in figure 3a but with some extra features. For the sake of clarity only the most relevant features will be shown in figure 5. The extra features may also be implemented in figure 4a, but using the preamplifier instead of the switch, see figure 6. Only figure 5 will be described. Figure 6 will work in a corresponding way.

The dashed lines indicating control are in these and the following figures only meant as schematic indications on which elements that belong together. Of course, the control signals goes normally via the not shown central processor, compare figure 3a and 4a.

Referring to figure 1, the gateway 7, 8 comprises the two gateway nodes 9a, 10a, 9b, 10b with the optional crossconnect 11 between the gateway nodes 9a, 10a. In figures 5 only one of the gateway nodes 9a, 9b is shown. The other gateway node 10a, 10b is similar.

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Without the crossconnect 11 the transmission routes are fixed once for all, but with the crossconnect 11 they are possible to change.

In figure 5 the first gateway node 9a, 9b in the gateway 7, 8 are connected to both the clockwise fibre 4 and the counterclockwise fibre 3. Traffic from the first fibres 3, 4 towards the two second fibres 5, 6 in another ring, is received in receivers 30. The traffic then goes via a first terminal multiplexer 31, the optional crossconnect 11, and a second terminal multiplexer 32 to the second gateway node 10a, 10b, which is connected to the two second fibres 5, 6.

Traffic from the second gateway node 10a, 10b to the first gateway node 9a, 9b goes in the opposite direction and is retransmitted in the first fibres 3, 4 by transmitters 33 in the first gateway node 9a, 9b.

A third detector 34, or a group of detectors 34, one per channel, detects if there is a loss of incoming power from the second terminal multiplexer 32, which indicates a fault and closes the switch 24. The fault handling described above occurs.

As was explained earlier the gateway nodes 9a, 9b, 10a, 10b always receive traffic from both fibres in the same ring, but only transmit away from its neighbouring gateway node. Together with the inactive segment this ensures that a node in a ring only receives traffic from one of the gateways.

But what happens, see figure 7, if the fault occurs between the two gateways 7 and 8? In this case the ring will reconfigure such that the gateways 7 and 8 form the end

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nodes of the ring 1. In that case all nodes 12a-d will receive traffic from both directions, which is not wanted.

That problem is however easily remediable by making the two gateways 7, 8 differing in one aspect. In this example the left gateway 7 in figure 5 comprises a condition detector 35, which may be the same as the second detector 23 not facing the right gateway 8. If the condition detector 35 detects a protection signal PS from the right gateway 8, the left gateway 7 suppresses transmission in the ring 1 in question by closing a switch 36. However, the left gateway 7 continues to receive traffic as usual and will stand-by for transmission. In the case of a subsequent failure in the right gateway 8, the left gateway 7 will detect that the protection signal PS is missing and will start transmitting again.

In the second embodiment in figure 6 information is sent in the supervision channel on in which segment the fault has occurred, which may be detected by the supervision unit 28 in the left gateway.

The possibility of detecting the case when the inactive segment is positioned between the gateway nodes opens up the possibility to place nodes also between the gateways. This requires a modification of the gateway nodes according to figure 8 or figure 9, respectively.

Figure 8 is the same as figure 5 and figure 9 is the same as figure 6, but with additional connections which makes it possible for the gateway nodes 9a, 9b to transmit in both directions. Only figure 8 will be described, but figure 9 will work in a corresponding way. It is to be understood

that in figures 8 and 9 the gateways are drawn next to each other by the sole reason of lack of space on the paper. The gateways are primarily meant to be used with nodes between them.

There is a second condition detector 37, which may be the same as the other second detector 23, serving the same purpose as the condition detector 36 mentioned above, that is to put a switch 38 in an off position in the case of a discovered protection signal. Either there may be two switches 36, 38 as drawn in figure 8, or else one switch that switches the one transmission line or the other. In this last version, however, the left gateway will not be in standby for the right gateway.

The result will be as in figures 10a and 10c, which depict the same network as in figures 1a, 3 and 7, but with the nodes 12c and 12d between the gateway nodes 9a, 9b instead. Figure 10b shows how the gateway nodes work schematically.

The ring will be "separated" in an upper part U and a lower part L. "Separated" means that a gateway node 9a, 9b will in the upper part U of the ring only transmit traffic destined for the nodes in the upper part U of the ring and will in the lower part L of the ring only transmit traffic destined for the nodes in the lower part L of the ring. Note that in order to make it work properly, different wavelengths $\lambda 1$, $\lambda 2$ and $\lambda 3$, $\lambda 4$ should be used in the two parts U, L of the ring.

In figure 10a the inactive segment 13 is positioned between the nodes 12c and 12d in the lower part L of the ring. Hence, both gateway nodes 9a, 9b transmit in the lower part L of the ring, while only the right gateway node 9b transmit

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in the upper part U of the ring. This is because the left gateway 9a will detect that the right gateway node 9b is transmitting in the upper part U of the ring and thus the left gateway 9a blocks transmission in that direction.

In figure 10c, on the other hand, the inactive segment 13 is positioned between the nodes 12a and 12b in the upper part U of the ring. Hence, both gateway nodes 9a, 9b transmit in the upper part U of the ring, while only the right gateway node 9b transmit in the lower part L of the ring. This is because the left gateway 9a will detect that the right gateway node 9b is transmitting in the lower part L of the ring and thus the left gateway 9a blocks transmission in that direction.

In all the embodiments above, a fault occurring in one of the gateways 7, 8 gives no more problem than any other fault. Since the two gateways 7, 8 are redundant it will be like using just one gateway 7 and with an inactive segment next to the faulty gateway 8.

This method also works with more than two rings and even though only optical embodiments are shown it will work in a similar manner in an electrical network.

CLAIMS

1. A method for protecting an interconnection between ring networks (1, 2), where signals are transmitted between at least two ring networks (1, 2), wherein each ring network (1, 2) comprises two communication paths (3, 4, 5, 6) working in opposite directions and at least one node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) connected to both communication paths (3, 4, 5, 6), wherein the said two ring networks (1, 2) are interconnected via two gateways (7, 8), each gateway (7, 8) is arranged to receive traffic from both communication paths (3, 4, 5, 6) on one ring network (1, 2) and to transmit said traffic to the other ring network (1, 2) on the communication path (3, 4, 5, 6) directed towards a first part (U) of the ring network (1, 2), c h a r a c t e r i z e d in that the traffic is stopped in both directions in a segment, called an inactive segment (13a, 13b), between two nodes (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) on each ring network (1, 2), so that a node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) situated on a ring network (1, 2) receives data traffic from the other ring network (2, 1) via only one of the two gateways (7, 8).

2. A method according to claim 1, c h a r a c t e r i z e d in that the inactive segment (13a, 13b) is achieved when the two nodes (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) on each side of the inactive segment (13a, 13b) on a ring network (1, 2) are end nodes and suppress reception from or transmission towards the direction of the inactive segment(13a, 13b).

3. A method according to claim 2, c h a r a c t e r i z e d in that if a fault occurs on the ring network (1, 2)

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somewhere else than in the inactive segment (13a, 13b), then the inactive segment (13a, 13b) is moved to the fault.

4. A method according to claim 3, c h a r a c t e r i z e d in that each end node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) transmits an own protection signal (PSa, PSb) on both communication paths (3, 4, 5, 6) connected to the end node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,), in that the protection signals (PSa, PSb) are not stopped by the inactive segment (13a, 13b), in that each end node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) detects the presence of the protection signals (PSa, PSb) and in that fault detection is made from the protection signal detection.

5. A method according to claim 3, c h a r a c t e r i z e d in that a alarm flag (SS) is sent in its own channel on both communication paths (3, 4, 5, 6) from node to node, in that the alarm flag (SS) is not stopped by the inactive segment (13a, 13b), and that the alarm flag (SS) is set if a fault is detected on the ring network (1, 2).

6. A method according to claim 4 or 5, c h a r a c t e r i z e d in that if the inactive segment (13a, 13b) is situated so that nodes in a part (U, L) of the ring network receive traffic from both gateways (7, 8), then one of the gateways (7) features a detection mechanism (23) that detects the situation and if said situation occurs, said gateway (7) suppresses transmission in said part (U, L) of the network.

7. A method according to claim 6, c h a r a c t e r i z e d in that each gateway (7, 8) transmits traffic to the other ring network (1, 2) also on the communication path (3, 4, 5,

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6) directed towards a second part (L) of the network, unless prohibited according to said detection mechanism.

8. A system for protecting an interconnection between ring networks, comprising two ring networks (1, 2), each ring network (1, 2) comprising two communication paths (3, 4, 5, 6) working in opposite directions and at least one node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10) connected to the communication paths (3, 4, 5, 6), said two ring networks (1, 2) being interconnected via two gateways (7, 8), each gateway (7, 8) being arranged to receive traffic from both communication paths (3, 4, 5, 6) on one ring network (1, 2) and to transmit said traffic to the other ring network (2, 1) on the communication path (3, 4, 5, 6) directed towards a first part of the ring network (1, 2), c h a r a c t e r i z e d in that a segment, called an inactive segment (13a, 13b), between two nodes (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) on each ring network (1, 2) is provided for not carrying any traffic, so that a node (12a, 12b, 12c, 12d, 9, 12e, 12f, 10,) situated on a ring network (1, 2) is provided to receive traffic from the other ring network (2, 1) via only one of the two gateways (7, 8).

9. A system according to claim 8, c h a r a c t e r i z e d in that one of the gateways (7) comprises a detection mechanism (23) that is arranged to detect the situation when the inactive segment (13a, 13b) is situated so that nodes in a part (U, L) of the ring network receive traffic from both gateways (7, 8), and in that said gateway (7) is provided to suppress transmission in said part (U, L) of the network if said situation occurs.

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10. A system according to claim 9, c h a r a c t e r i z e d in that each gateway (7, 8) is provided to transmit traffic to the other ring network (1, 2) also on the communication path (3, 4, 5, 6) directed towards a second part (L) of the network, unless prohibited according to said detection mechanism.

BNSDOCID: <WO_____9903231A1_I_>

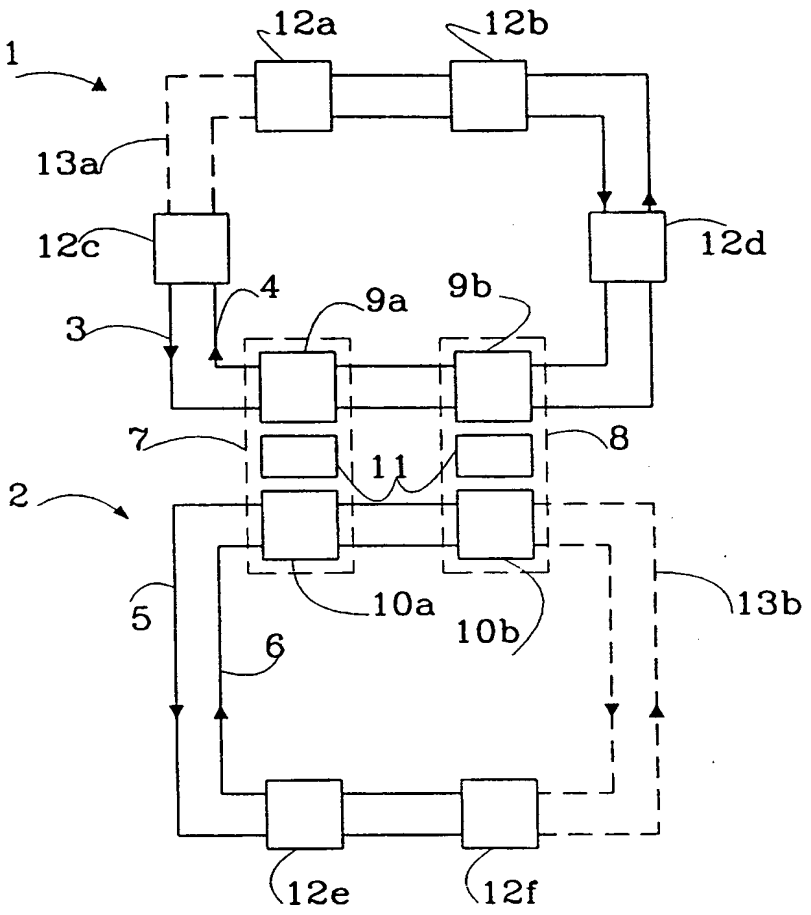


Fig 1a

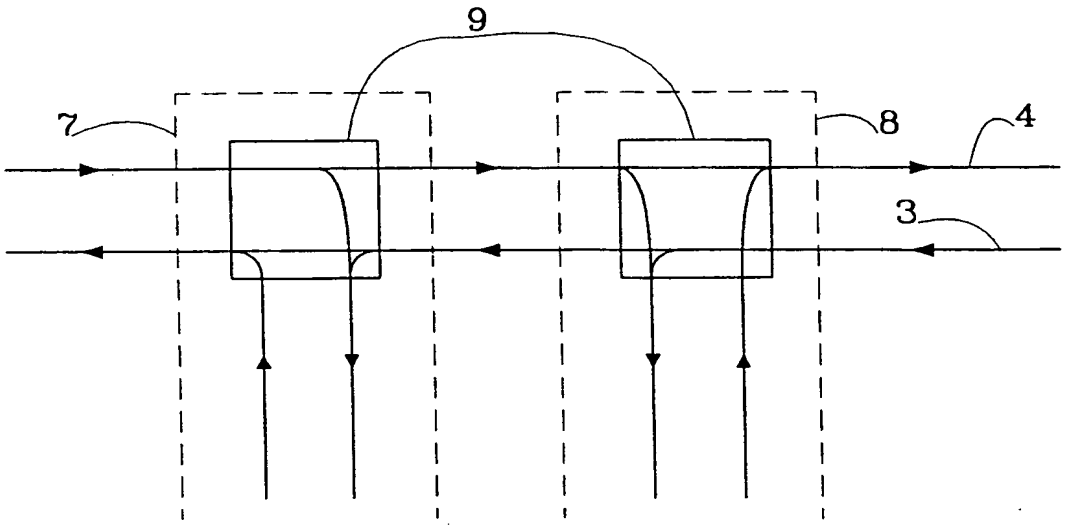


Fig 1b

BNSDOCID: <WO_____9903231A1_1_>

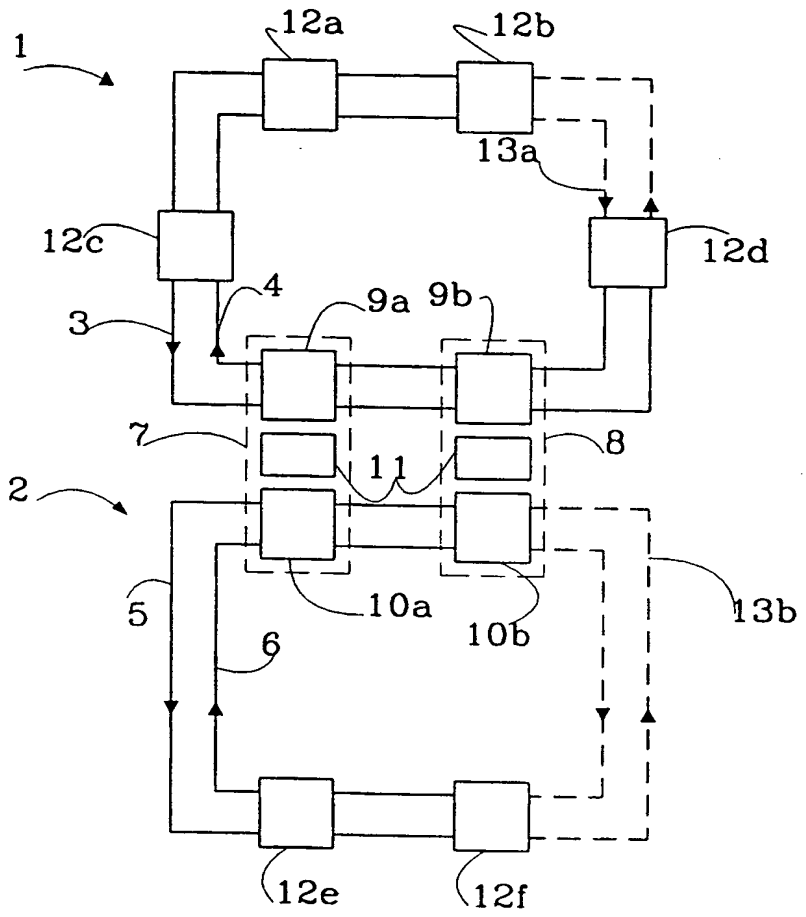


Fig 2

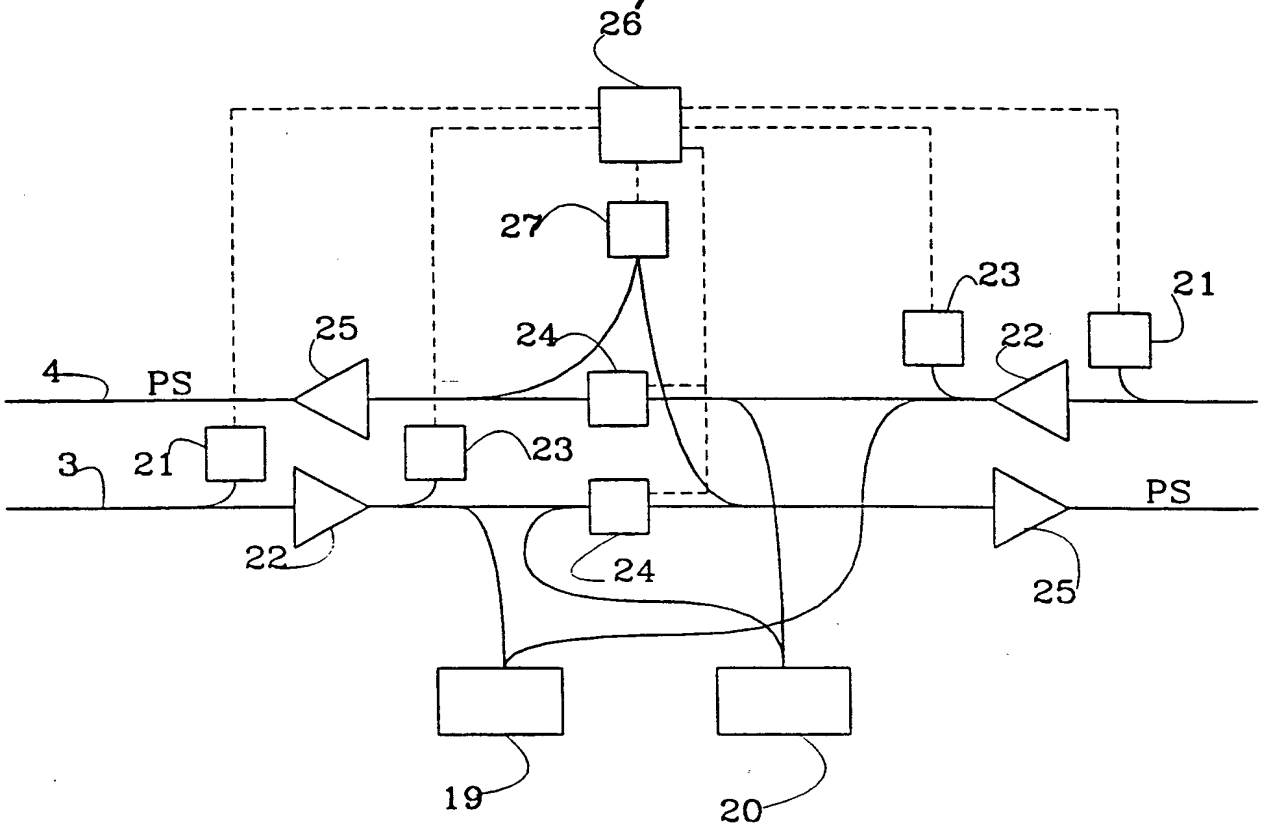


Fig 3a

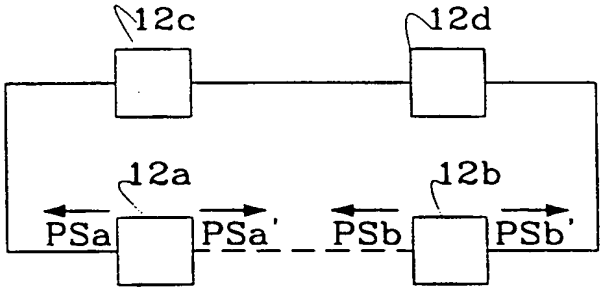


Fig 3b

BNSDOCID: <WO_____9903231A1_I_>

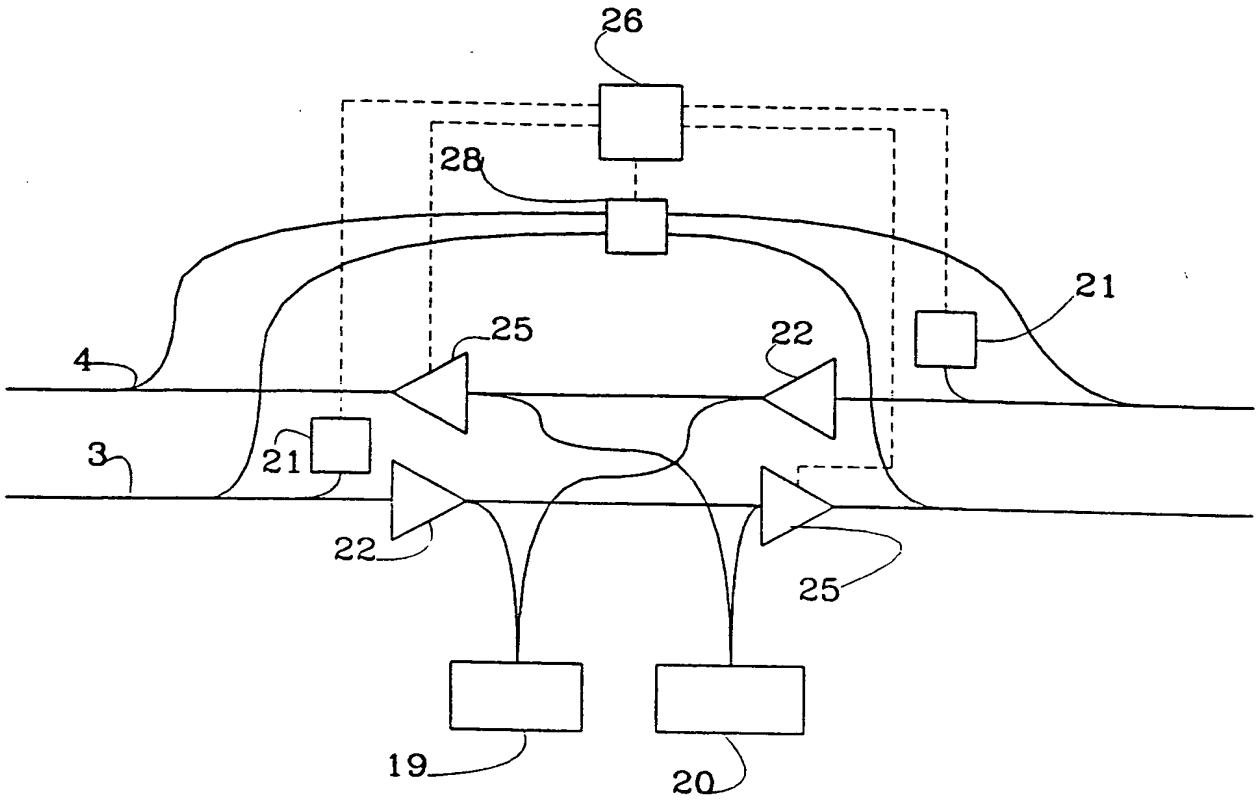


Fig 4a

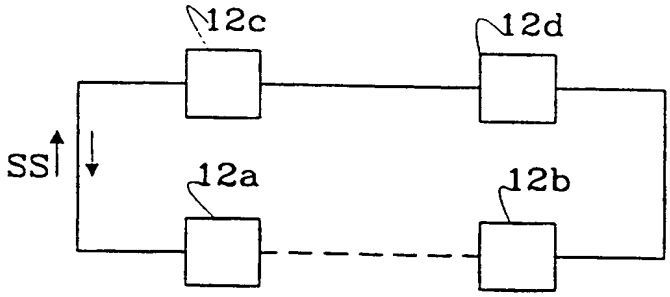


Fig 4b

BNSDOCID: <WO_____9903231A1_I_>

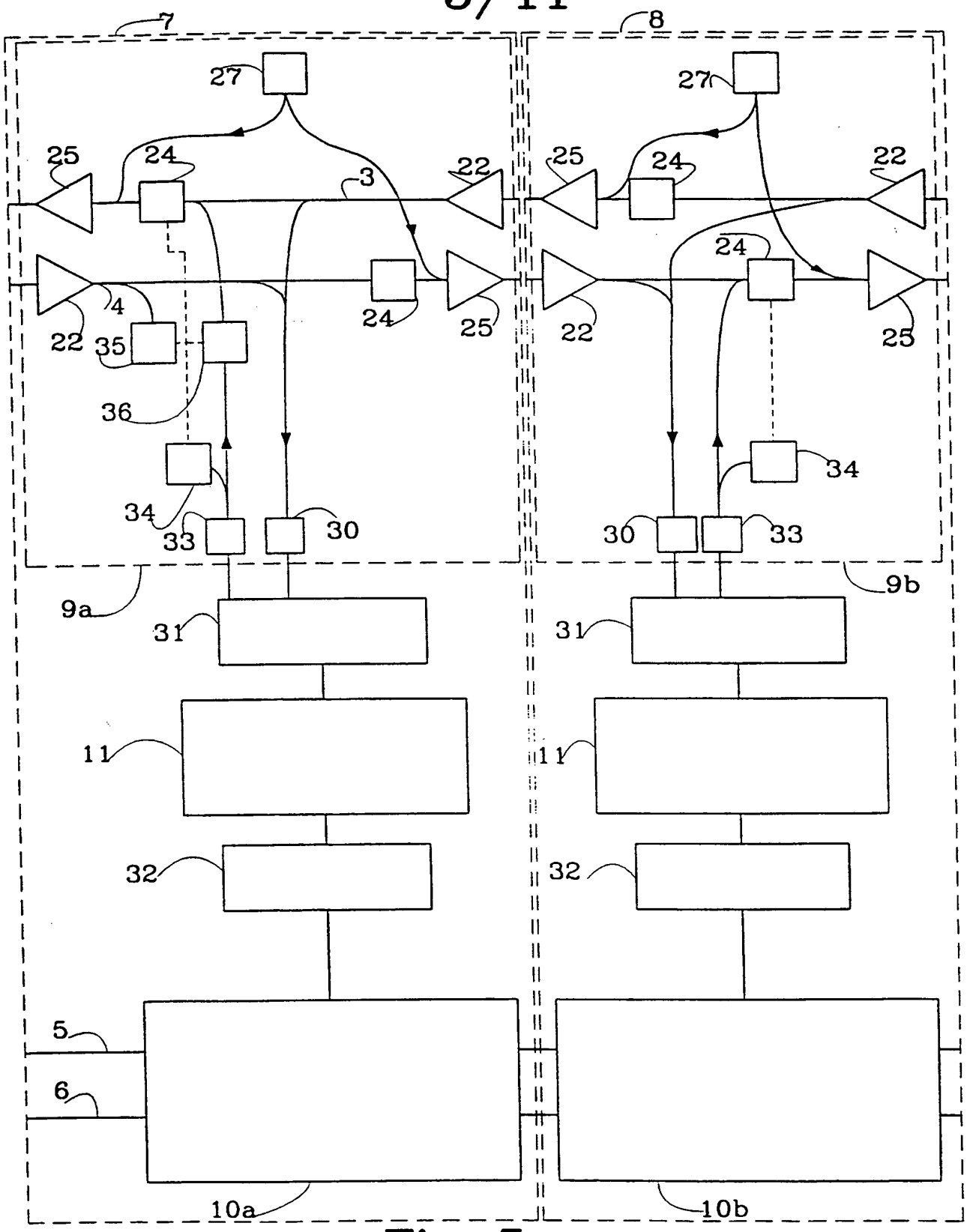
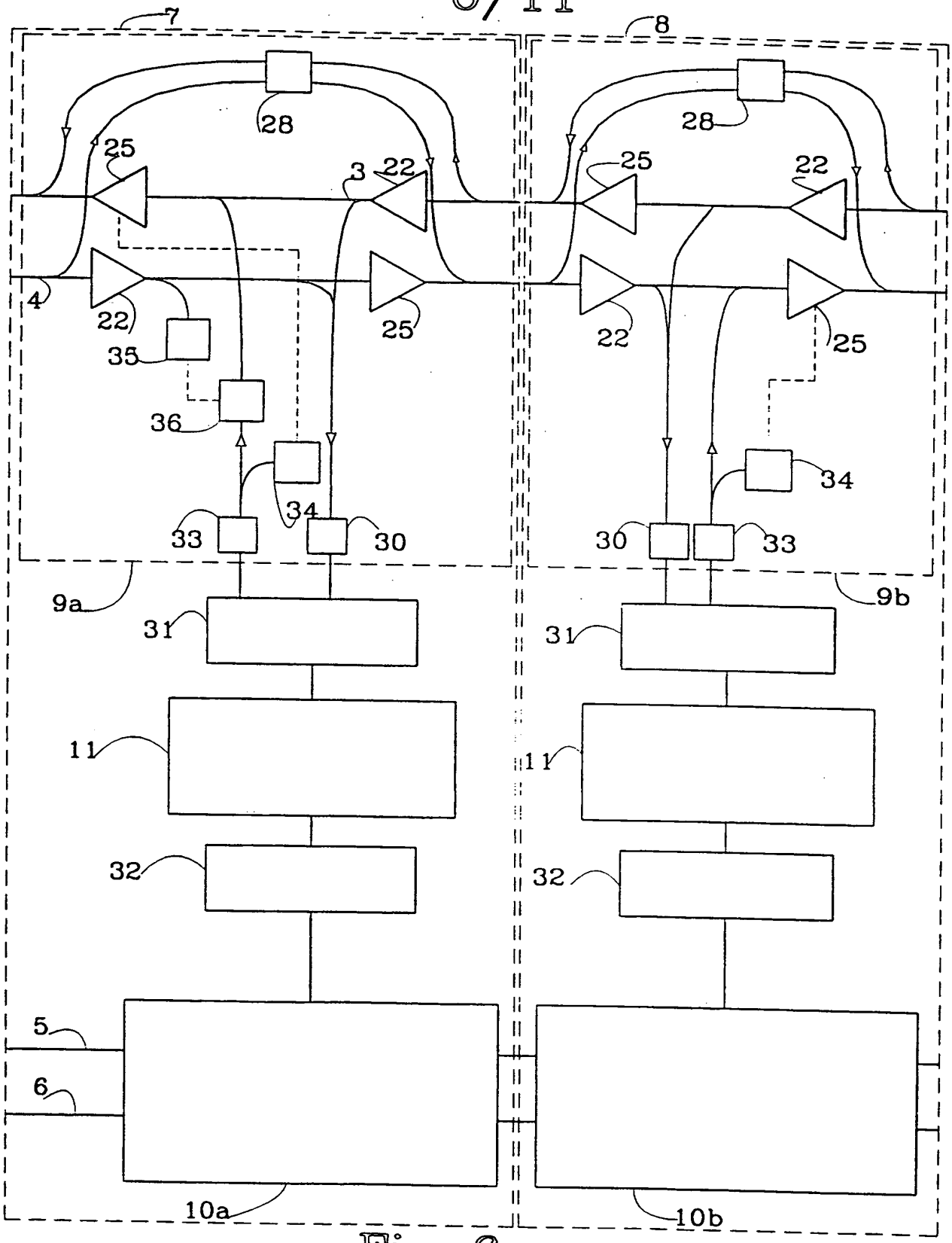


Fig 5

BNSDOCID: <WO_____9903231A1_I_>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10a
10b

Fig 6

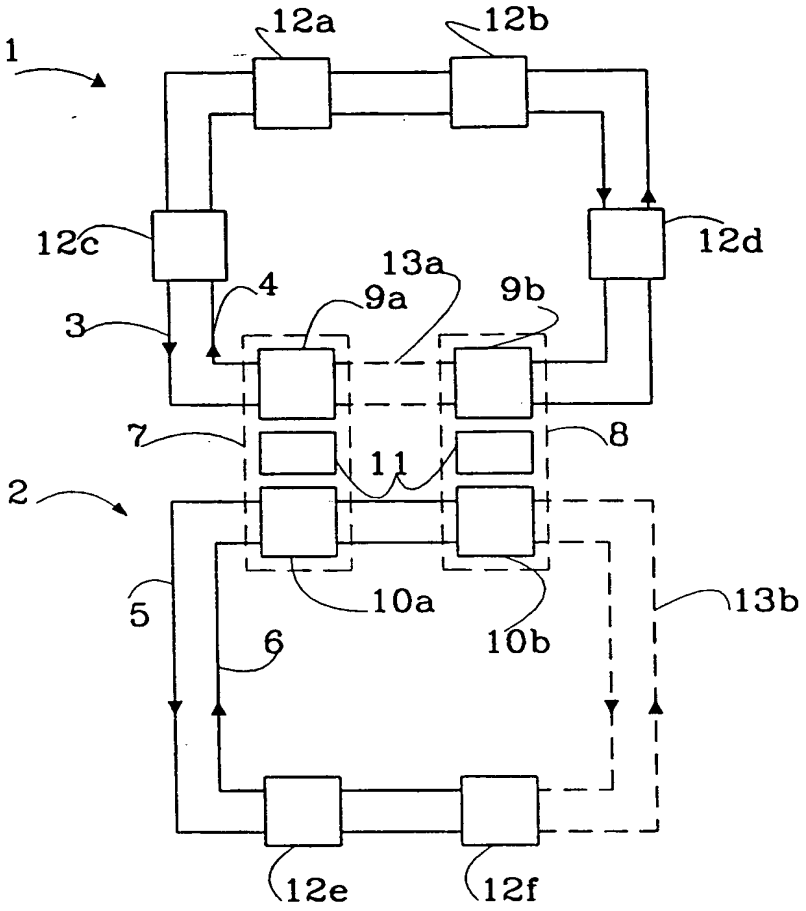

Fig 7

BNSDOCID: <WO_____9903231A1_I_>

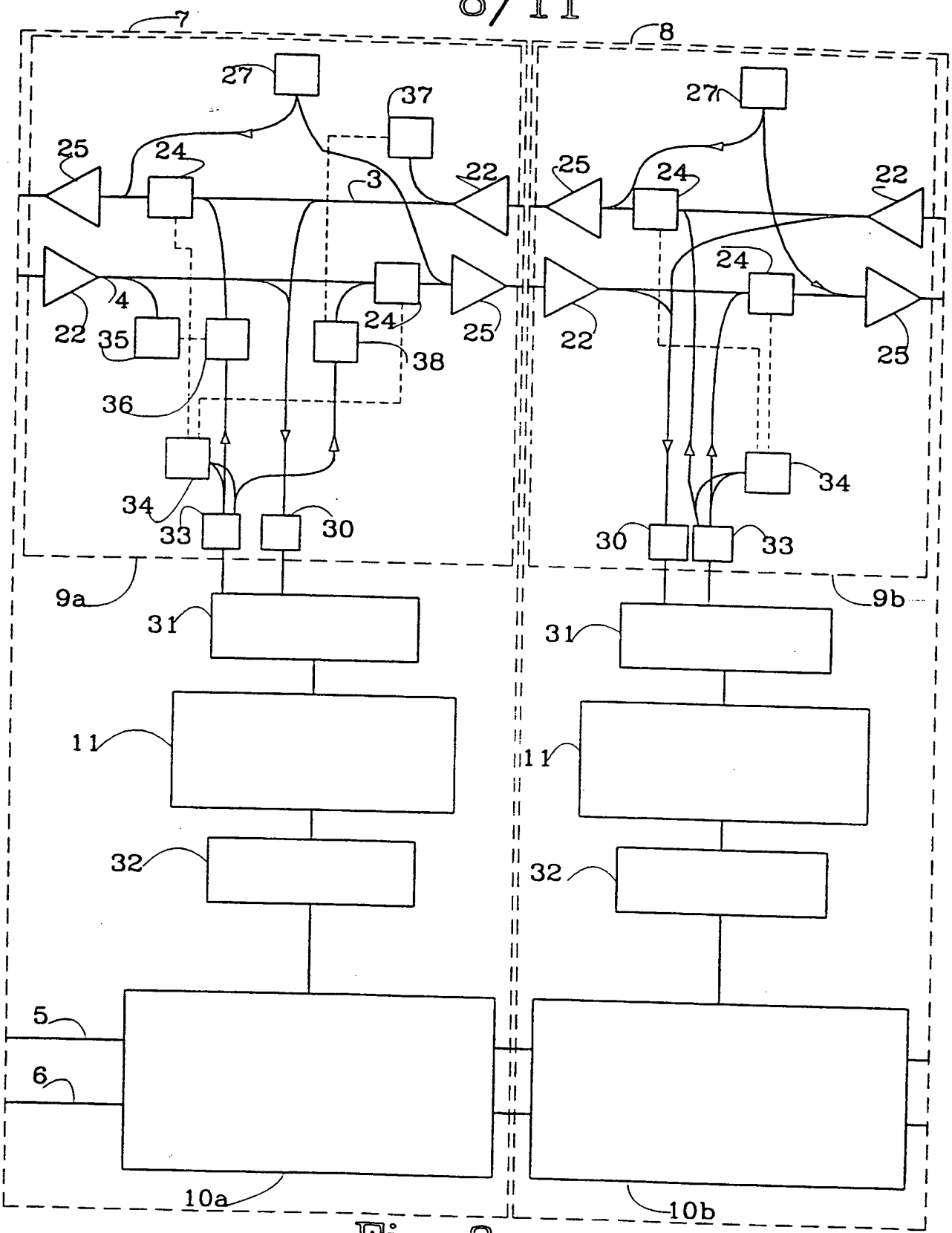

Fig 8

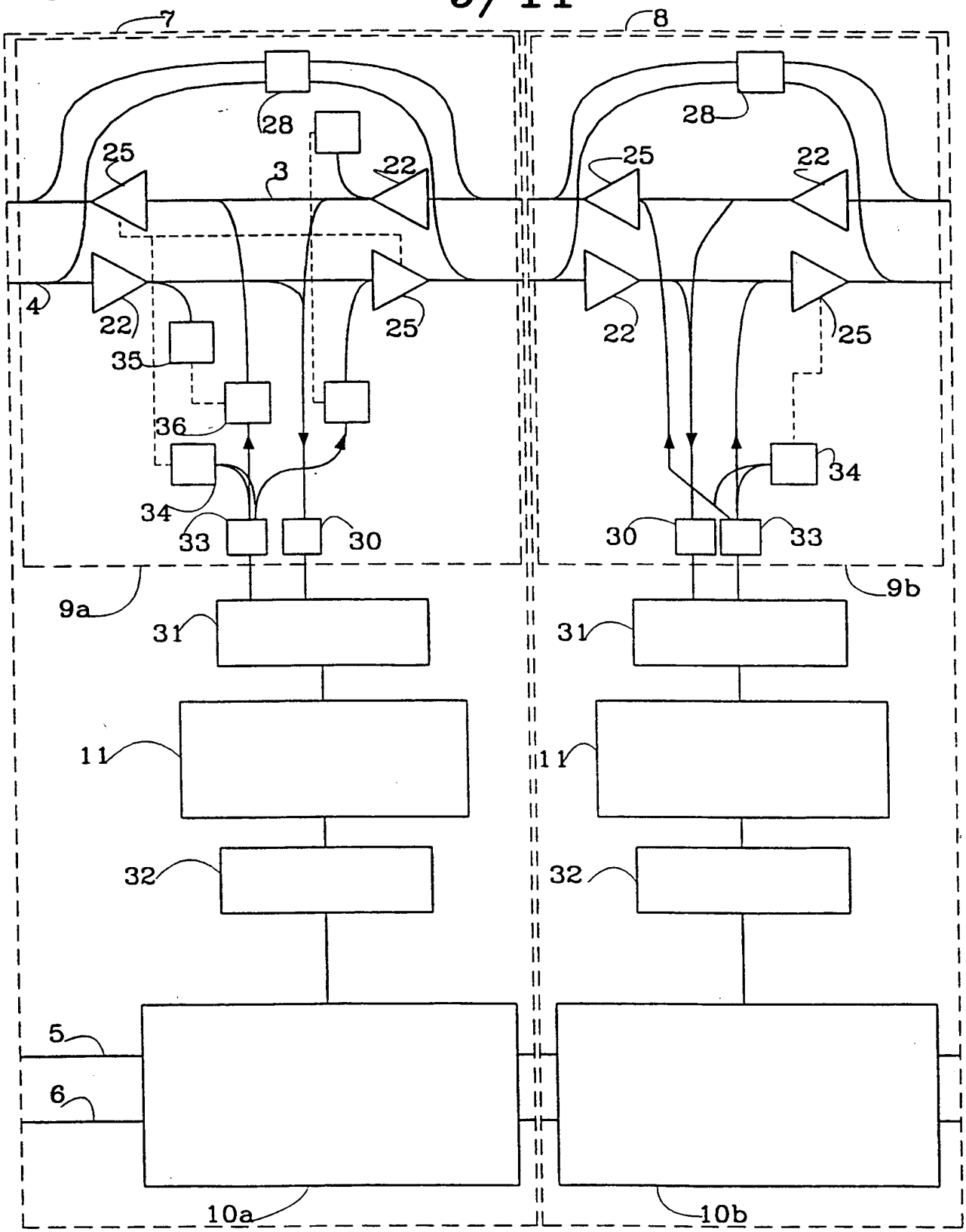

Fig 9

BNSDOCID: <WO_____9903231A1_I_>

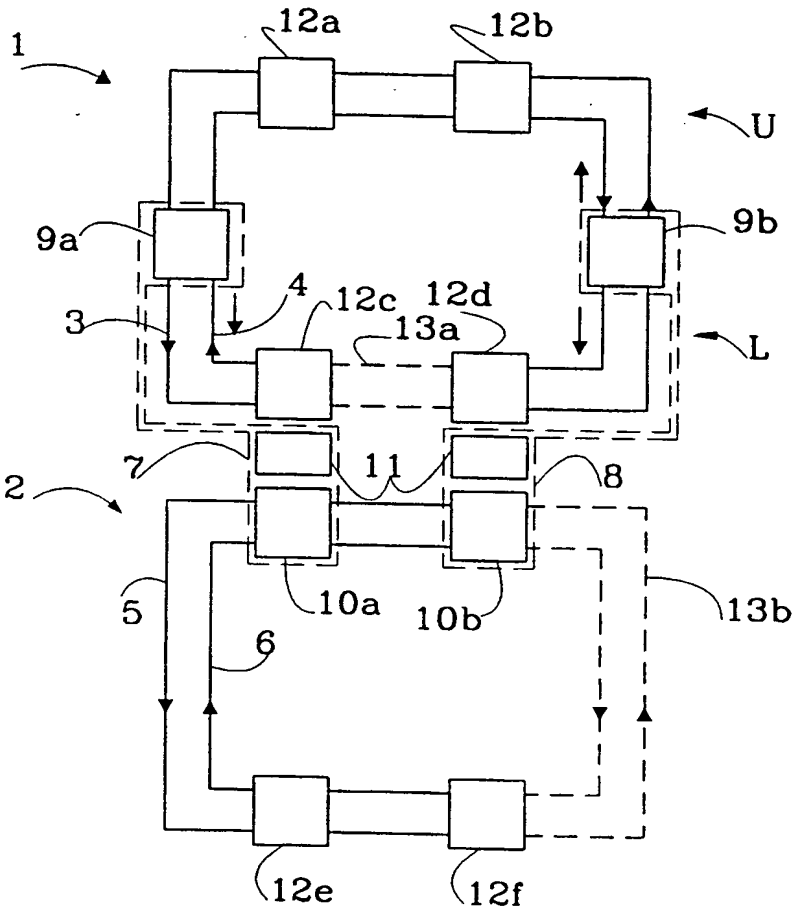

Fig 10a

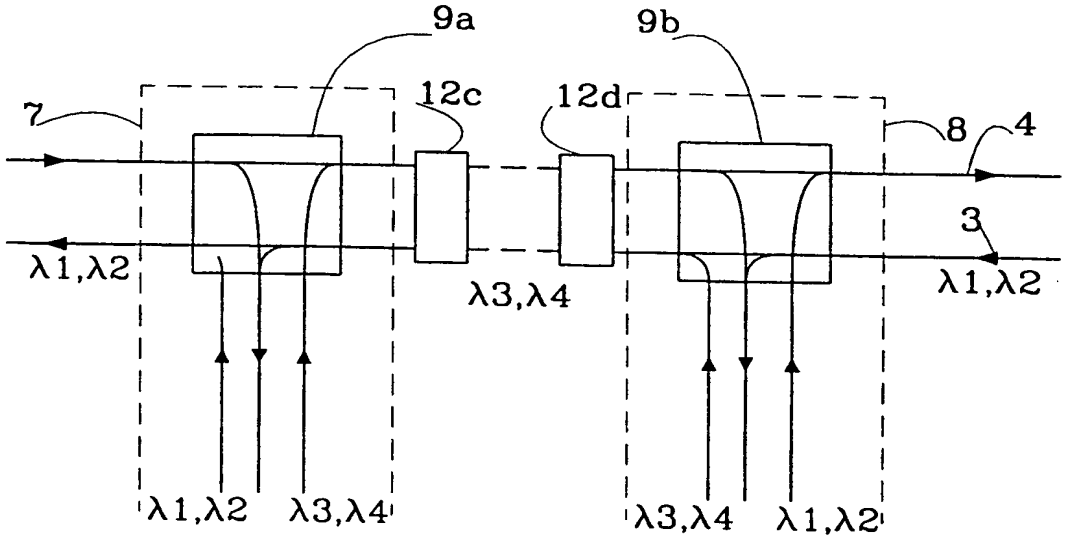

Fig 10b

BNSDOCID: <WO_____9903231A1_I_>

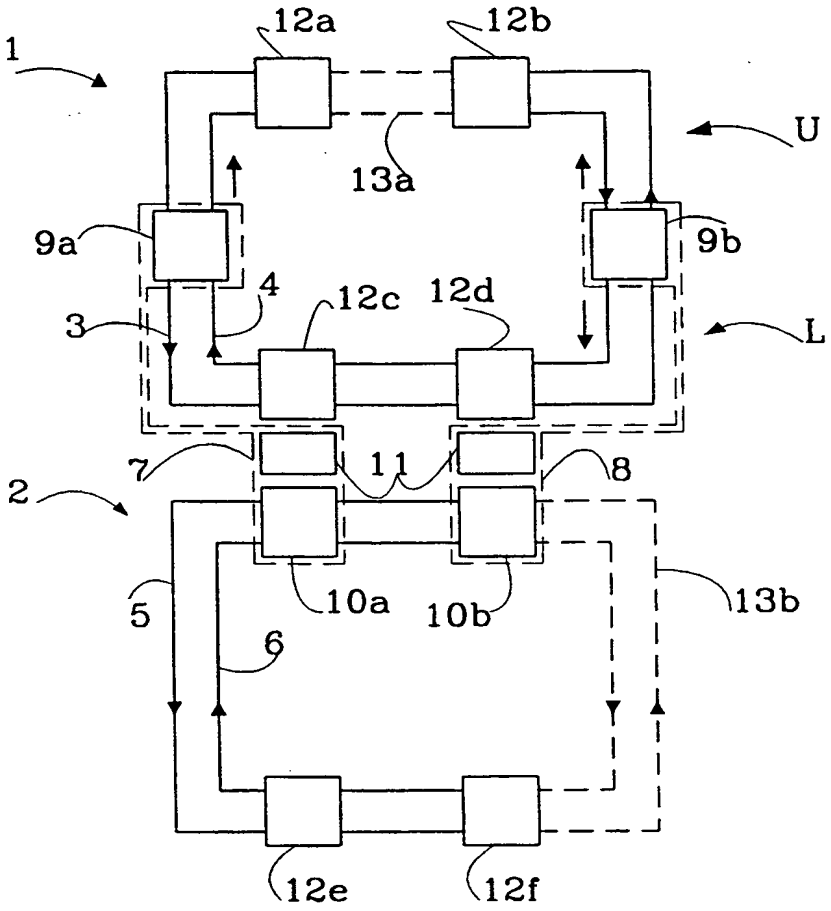

Fig 10c

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01064

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04L 12/46, H04J 3/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04L, H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL, EDOC, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ANNUAL REVIEW OF COMMUNICATIONS, Volume 48, 1994, (CHICAGO, USA), G.W. ESTER, "Comparison of Ring Architectures, and Their Application in the Network" page 955 - page 962 --	1-3,8
Y	ELECTRONICS LETTERS, Volume 32, No 25, December 1996, B.S. Johansson et al, "A SELF-RESTORING OPTICAL ADM RING ARCHITECTURE" page 2338 - page 2339 --	1-3,8
A	US 5491686 A (KENJI SATO), 13 February 1996 (13.02.96), column 7, line 38 - line 54, figure 1, abstract --	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"E" erlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 October 1998	23 -10- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anders Ströbeck Telephone No. +46 8 782 25 00

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BNSDOCID: <WO_____9903231A1_I_>

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01064

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5113459 A (GIORGIO GRASSO ET AL), 12 May 1992 (12.05.92), column 2, line 16 - line 37	4-7,9,10
A	WO 9204788 A1 (BELL COMMUNICATIONS RESEARCH INC.), 19 March 1992 (19.03.92), page 6, line 7 - page 7, line 2	1-10
A	US 5440540 A (WILHELM KREMER), 8 August 1995 (08.08.95), abstract	1-10
A	US 4577313 A (KIAN-BON K.SY), 18 March 1986 (18.03.86), figure 1B, abstract	1-10
A	NEC RESEARCH & DEVELOPMENT, Volume 36, No 4, October 1995, (TOKYO, JAPAN), NAKAGAWA ET AL, "Development of SONET 2.4 Gbps 4-Fiber Ring Network System" page 535 - page 544	1-10

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

BNSDOCID: <WO_____9903231A1_I_>

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
PCT/SE 98/01064

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 5113459 A	12/05/92	AT 134808 T	15/03/96
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